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Abstract of a Register of the Barometer, Thermometer, and Rain, at Lyndon, in Rutland, for the year 1798. By Thomas Barker, Esq. Read Dec. 12, 1799. [Phil. Trans. 1800, p. 46.]

On the Power of penetrating into Space by Telescopes; with a comparative Determination of the Extent of that Power in natural Vision, and in Telescopes of various Sizes and Constructions; illustrated by select Observations. By William Herschel, LL.D. F.R.S. Read Nov. 21, 1799. [Phil. Trans. 1800, p. 49.]

It has long been observed that the power of distinguishing objects at great distances depends not only on the magnifying power applied to the telescope through which they are viewed, but also on the quantity of light emitted by the object, and collected and conveyed to the eye by means of the instrument. The superiority of telescopes with large apertures must hence appear obvious; and we have long witnessed the essential improvements made in this respect by Dr. Herschel, which have enabled him to extend his view into the firmament to distances, the bare mention of which is sufficient to astonish a mind unaccustomed to investigations of this nature. That it is principally the increased quantity of light that enables us to view luminous objects at great distances will appear manifest if we reflect that, since the density of light decreases in the ratio of the squares of the distances of the objects emitting the light, it follows that an object may be removed to distances at which its light will be so rarefied as to produce no longer any sensation upon the optic nerve: that if an optical instrument be used with an object-glass of a larger diameter than the pupil of the eye, the quantity of light collected by this means in the eye will be greater in proportion to the greater extent of the object-glass compared with that of the pupil: and that hence the most distant star that can be seen with the naked eye, if it be viewed through a tube with an object-glass of twice the diameter of the pupil, it will without any magnifying power be visible at a distance four times greater than that at which the naked eye ceased to perceive it. Dr. Herschel many years ago adverted to this circumstance, when in his paper on the Construction of the Heavens, he introduced what he then figuratively called *his sounding line*, to which he now substitutes the appellation of the *power of penetrating into space*. And in the present paper he fully investigates a comparative determination of the extent of that power in natural vision, and in telescopes of various sizes and constructions; all which he illustrates by a number of select and curious observations.

In the first part of the paper he establishes the difference between magnifying and penetrating powers; he rejects some vague terms in common acceptation, to which he substitutes algebraic symbols and such accurate definitions as enable him to proceed upon solid ground. And after distinguishing between self-luminous objects and those which shine by a reflected light, and likewise noticing those whose

brightness is the effect of a considerable depth of luminous matter, he shows that these differences noways affect the present inquiry ; since in all these several bodies, it is the quantity of light emitted by their surfaces which becomes the object of our perception. As the same body, however, may be differently luminous in different parts of its surface, he exhibits a formula by which the aggregate brightness of a body may be estimated. And he closes this part with an examination of the opinion maintained by Lambert in his *Système du Monde*, where he says that an object is equally bright at all distances, and that the sun at the distance of Saturn, or still further from us, would be as bright as it is in its present situation. This assertion taken in the general sense in which it is here expressed, he proves to be a palpable contradiction ; and only admits it in as far as the celebrated author may mean the *intrinsic brightness* of a body, which applies to its surface diminished by distance, and not the *absolute* brightness of the whole.

In the next section the author endeavours to ascertain the general extent of vision with the naked eye. As to those bodies which shine with a reflected light, he asserts that none have yet been seen more distant than the Georgian planet : admitting this as the maximum, it must after all excite our admiration that borrowed light should be perceptible to our naked eye at the distance of no less than eighteen hundred millions of miles ; especially if we consider that the light of the sun on that planet is above 368 times less intense than it is on our earth, and that probably two thirds of that diminished light is absorbed by the planet.

The range of natural vision, with respect to self-luminous objects, is incomparably more extended. Passing over the intermediate steps by which our author arrives at his conclusions, we shall simply mention his inference that no single star above nine or at most ten times more distant than Sirius can possibly be perceived by the naked eye ; admitting, however, that an accumulation of stars will be perceptible at a far greater distance.

From the power of penetrating into space by naked vision, our author proceeds to that of telescopes. Here he first calculates, by a method recommended by Mr. Bouguer, the quantity of light absorbed and dissipated by the reflection of the mirror, and refraction of the eye-glasses ; and he finds that a common Newtonian with three lenses loses about $\frac{9}{10}$ ths of the whole light it receives, and that in a telescope of his own construction with two lenses this loss amounts to somewhat less than $\frac{1}{10}$ ths. The Doctor now enters into a full investigation of the penetrating power of his several telescopes under all the various circumstances he could devise, and illustrates the whole by a great number of observations, which serve to confirm the inferences deduced by him. Here we learn that the penetrating power of his 20-feet reflector, applied to a single star, may extend as far as 612 times the distance of Sirius, and also that his large telescope, with a penetrating power of 192, will show a single star of the 1342nd magnitude.

In the next sections he shows that the penetrating and magnifying powers, so far from assisting each other, will often prove reciprocally detrimental, which he thinks may be explained by admitting that while the light collected is employed in magnifying an object, it cannot be exerted in giving penetrating power, to which perhaps ought to be added the detrimental effect of the magnifying power on the heterogeneous ingredients floating in the atmosphere. Whatever be the cause, the fact is proved by various observations.

Lastly, he shows that as we must not limit our vision within the sphere of the single stars, we must call the united lustre of the sidereal system to our aid in stretching forward into space. Supposing one of these clusters of 5000 stars to be at one of those immense distances to which only a 40-feet reflector can reach, he calculates that this distance will exceed at least 300,000 times that of the most remote fixed star visible to the naked eye. He concludes with a rough calculation how much time it would take to sweep the heavens with a penetrating power of such an immense extent; and finds that in this climate, with his 40-feet reflector, with a magnifying power of 1000, this operation for the whole sphere would take no less than 811 years.

A second Appendix to the improved Solution of a Problem in physical Astronomy, inserted in the Philosophical Transactions for the Year 1798, containing some further Remarks, and improved Formulæ for computing the Coefficients A and B; by which the arithmetical Work is considerably shortened and facilitated. By the Rev. John Hellins, B.D.F.R.S. and Vicar of Potter's Pury in Northamptonshire. Read Dec. 12, 1799. [Phil. Trans. 1800, p. 86.]

This paper relates to an improved solution of a problem by which swiftly converging series are obtained, which are useful in computing the mutual perturbations of the planets; and contains some further remarks and improved formulæ for computing the coefficients, by which the arithmetical work is considerably shortened and facilitated.

Account of a Peculiarity in the Distribution of the Arteries sent to the Limbs of slow-moving Animals; together with some other similar Facts. In a Letter from Mr. Anthony Carlisle, Surgeon, to John Symmons, Esq. F.R.S. Read Jan. 9, 1800. [Phil. Trans. 1800, p. 98.]

This peculiarity was first observed in the axillary arteries and in the iliacs of the Lemur tardigradus, which at their entrance into the upper and lower limbs were found to be suddenly divided into a considerable number of equal-sized cylinders, which occasionally anastomosed with each other, and were regularly distributed on the muscles; whilst the arteries proceeding to the other parts of the body divided in the usual arborescent form.

Upon prosecuting this inquiry, it was found that the Bradypus